IFDM System Management

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Chapter 6. IFDM System Management

A. Introduction

During the design and development of an IFDM system, the farmer and designer must decide on system management because each system will be different. The final design presented to the farmer should have a description of the management required to ensure success of the operation. It is not practical to attempt to describe the management for an undefined system. However, it is possible to describe the areas where management will be required as a starting point for the development of individual plans.

There are several major areas that will require management plans. The first is the irrigation system. If the farmer is continuing with an existing system then the designer will have evaluated the current practice and will have made suggestions as to what, if anything, can be improved. If there is to be a new type of irrigation system installed, then the designer will have to develop a specific set of operational and management plans.

The second area of management is salt. The farmers on the west side of the San Joaquin Valley typically manage salt by applying excess water and leaching it from the soil profile. When drainage was possible, the effort was made to leach the soil without any regard to the volume of salt being moved through the profile, but this will have to change.

The third area of management is the drainage system. This will be a completely new concept for the farmer. In the past, drains were designed to run continuously without regard to the consequences. The drains were often installed deep into the soil profile to ensure that salination of the root zone and soil surface would not occur. This will not be an acceptable practice in an IFDM system.

The fourth area is the solar evaporator. This will be a major change because it is new to the farmer and the operation will be monitored and regulated by the State of California. The consequences of mis-management in the other areas (irrigation, salt, and drainage system) will be the loss of productivity and extra water for disposal. Poor management of the solar evaporator will have specific and defined consequences that will be determined by the State.

Finally, selenium management in the soils and crops will have to be considered in the overall plan. This will not be a straightforward process but will be included in the salt management, the water management, and the crop selection.

B. Irrigation Management

Irrigation management strategies may have the single greatest impact on the operation of an IFDM system. Adopting management practices to control deep percolation losses (source control) will affect the size and complexity of the solar evaporator, as well as the area required for production of salt-tolerant crops. As indicated in previous sections, the less deep percolation, the smaller will be the area needed for production of salt-tolerant crops.

Research shows the pre-plant irrigation and the first seasonal irrigation are the most inefficient irrigations, when using surface irrigation. Efficiencies are improved when using sprinklers for these two irrigations. Using sprinklers for pre-plant irrigation results in less deep percolation losses and the water is more uniformly applied. Sprinkler irrigation also is more effective in leaching salts than surface irrigation for a given quantity of water. The goal of the pre-plant irrigation is to manage the salt in the soil surface for germination and in the root zone, while minimizing drainage water volume.

The first irrigation of the season also is problematic with surface irrigation because the available soil water storage is very low when plants are small and use little stored soil water. Surface irrigation will result in excess deep percolation. Opting for sprinklers on the first irrigation can solve the problem since the depth of application is controlled by the sprinkler runtime and not the infiltration rate of the soil surface as with surface irrigation. Controlling water volumes on the first irrigation is always problematic and can hinder production by saturating the root zone during a critical stage in the early growth of the crop. Sprinkler irrigation limits the amount of water applied, and therefore, limits drainage volumes while maximizing plant growth potential.

For drip irrigation, consideration must be given for management of the salt and crop germination. This might require use of sprinklers for germination. Pre-plant irrigation has been effectively used for salt control so this will not be a problem. Depending on the crop, it may be possible to use transplants, which will limit the need for water for germination.

For surface irrigation, there is a requirement related to standing water and wildlife safety. This should not be a problem since standing water would suggest that the field needs to be graded to eliminate the water, which will have a secondary effect of reducing water logging. The question is how to manage any tailwater ponds that are incorporated in the design of the system. This will be addressed in the design of the system and in the management plans approved by the State.

No standing water is one of the criteria to be addressed in the management plan. State law prohibits standing water for more than 48 hours. (Appendix Draft (Title 27/SB1372) Solar Evaporator Regulations, pages A-79 to A-88) Some management options to address this are proper irrigation scheduling, shorter runs/smaller blocks, maintaining infiltration rate with an amendment program, and proper leveling. Proper leveling will ensure that surface runoff will occur, and that excess water may be collected in a tailwater pond. The volume of runoff will be reduced by maintaining the infiltration rate.

Blending of saline and good quality water may become an issue at some point in IFDM system management. In some cases, the saline water will need to be blended to reduce the salinity to match the salt tolerance of the crop. This was discussed in the section on alternatives for using saline water in Chapter 4. There will need to be provisions in the design of the irrigation and drainage systems to blend water. Several alternatives can be explored, and the current systems operating in the San Joaquin Valley can be used as examples.

Water can be mixed in a sump and discharged to the field or the separate sources can be mixed in the pipe delivering water. The method selected will be determined by the physical layout of the system. If the runoff of the blended water contains salt and other elements that may be of regulatory concern, a management system must be developed. Reapplying the runoff water on a salt-tolerant crop will be the simplest method. If the saline water doesn't need to be blended then the cyclic method proposed by Rhoades (1989) would be an efficient technique to consider. The production areas containing salt-tolerant crops being irrigated with saline water will require some fresh water to manage the salt in the root zone.

Another aspect of irrigation management that may not be familiar to the manager is setting yield goals less than maximum yield and irrigating to this reduced yield level. This may result in maximum profits. This becomes apparent when a crop production function is considered. The last increment of yield to maximize production is the least efficient when water use is considered, so a reduction in applied water will not result in an equivalent reduction in yield. This may result in reduced cost of production without a significant yield loss. In this case, the farmer is irrigating for economic irrigation efficiency, which is defined at the farm level as the irrigation management that results in maximum profit.

A side benefit of this approach is that deep percolation losses are reduced. Often, the last increment of irrigation water is applied to compensate for irrigation inefficiency, and by not applying this increment, there is only minor yield reductions and less deep percolation. In an IFDM system, significant deep percolation reduction will have a positive impact in the reduction of drainage water for disposal.

C. Salt Management

Farmers are aware of the basics of salt management. Salt in the soil is not good and it must be eliminated for production of salt-sensitive crops. The management solution has been to install subsurface drains and apply water to leach the salt and to keep on applying water. This will remove the salt from the root zone and from areas deep in the soil. However, this is no longer an acceptable practice unless the management goal is to accumulate a large mass of salt on the farm.

The approach with an IFDM system is to manage the salinity in the root zone such that the crop production can be maintained and the salt load from the drains is minimized by controlling the deep percolation losses. Salinity is a problem in the root zone, but not in the portion of the soil profile not habituated by roots. When possible, consideration should be given to salt storage in the soil profile if this can be done without negatively impacting yield. More salt stored in the soil profile results in less salt to be managed at the solar evaporator. During excessive precipitation, excess salts stored in the soil profile will be moved through the subsurface drainage system and toward the solar evaporator. In a controlled drainage system, it may be desirable to store salts and then periodically leach them under controlled conditions.

Management strategies will change over time. Even in the first production area, high initial soil salinity may call for a more salt-tolerant crop rotation and an intensified reclamation program. Later on, as soil salinity moderates and soil salts are relocated away from the root zone, a more salt-sensitive crop rotation may be implemented along with stringent source control and reduced leaching fraction. Management is not a static quantity. It will be constantly in a state of flux and the management plans will have to change as the farmer gains experience with the system. The driving force for change will be the constantly changing environmental conditions and economic climate.

The salt management strategy will be dictated by the cropping pattern and the drainage water quality. The drainage water quality will remain fairly constant with time but the cropping may change as the soil in an area is reclaimed to a desired level so the cropping can be changed.

Soil Amendments

Farmers are familiar with the application of soil amendments to improve infiltration and soil permeability to water. With long-term application of saline-sodic drainage water to IFDM reuse areas, infiltration and soil permeability to water may decline appreciably. Surface applications of gypsum, soil sulfur or sulfuric acid are likely to be required and at rates higher than those used in conventional agriculture. Organic amendments also may have potential to mediate the negative effects of sodic irrigation waters. However, this has not been demonstrated.

D. Drainage System Management

Drainage system management will be a major departure from the farmer's experience. In the past, the drains were allowed to run continuously and it was assumed that this was required to prevent soil salinization and water-logging. However, research shows this is not the case, and the water table can be controlled at depths of approximately four feet below the soil surface without adverse impacts. This type of control limits the total drainage flow, and as a result also reduces salt load being discharged.

This type of control requires the drainage system laterals to be installed perpendicular to the surface grade and have a control structure. This control structure will have a weir board or device that can be positioned to maintain the water table at the desired level. Depending on the field size and layout, several control structures may be required.

Shallow groundwater levels can be manipulated to enhance leaching or to encourage the crop to use shallow groundwater as a water source. The ability of the crop to tolerate salt varies during the course of the growing season. The crop can use a tremendous volume of drainage water if it is within reach of the roots. This also suggests that for annual crops, the water table may be set closer to the ground surface early in the season and lowered as the season progresses to ensure adequate aeration of the root zone. Care will have to be exercised to ensure that the crop root zone is not waterlogged for an extended period following irrigation when the water table is controlled close to the root zone.

It is important the drainage system is operated in concert with the irrigation system. These two systems must become an integrated water management system.

E. Solar Evaporator

Solar evaporator management will be a new experience for farmers because it is the one components of IFDM that is new to them. There is a learning curve for all concerned to understand how the system works and how it is included in the operation of the farm. It is critical the designer develop detailed scenarios on the management. The experience of AndrewsAg and others with operating systems will be valuable as the management program develops (See Chapter 2).

Solar evaporator management must comply with §22940.SWRCB-Solar Evaporator Operation Requirements:

a *Limitation on Standing Water – The solar evaporator shall be operated so that, under reasonable foreseeable operating conditions, the discharge of agricultural drainage water to the solar evaporator will not result in standing water, outside the water catchment basin. Agricultural drainage water from the IFDM system shall be* *discharged to the solar evaporator by timed sprinklers or other equipment that allows the discharge rate to be set and adjusted as necessary to avoid standing water in the solar evaporator.*

b Prevention of Nuisance – The solar evaporator shall be operated so that, under reasonably foreseeable operating conditions, the discharge of agricultural drainage water to the solar evaporator does not result in:
(1) The drift of salt spray, mist, or particles outside the boundaries of the solar evaporator, or
(2) Any other nuisance condition.

c Prohibition of Outside Discharge – The operation of a solar evaporator shall not result in any discharge of agricultural drainage water outside the boundaries of the solar evaporator.

d Salt Management – For solar evaporators in continuous operation under a Notice of Authority to Operate issued by a Regional Water Quality Control Board, evaporte salt accumulated in the solar evaporator shall be collected and removed from the solar evaporator if and when the accumulation is sufficient to interfere with the effectiveness of the operation standards of the solar evaporator as specified in this section. One of the following three requirements shall be selected and implemented by the owner or operator:
(1) Evaporite salt accumulated in the solar evaporator may be harvested and removed from the solar evaporator and sold or utilized for commercial, industrial, or other beneficial purposes.
(2) Evaporite salt accumulated in the solar evaporator may be stored for a period of one-year, renewable subject to an annual inspection, in a fully contained storage unit inaccessible to wind, water and wildlife, until sold, utilized in a beneficial manner, or disposed in accordance with (3).
(3) Evaporite salt accumulated in the solar evaporator may be collected and removed from the solar evaporator, and disposed permanently as a waste in a facility authorized to accept such waste in compliance with the requirements of Titles 22, 23, 27 and future amendments of the CCR, or Division 30 (commencing with section 40000) of the Public Resources Code.

e Monitoring – Monitoring and record keeping, including a groundwater monitoring schedule, data, and other information or reporting necessary to ensure compliance with this article, shall be established by the RWQCB in accord with §25209.14 of Article 9.7 of the Health and Safety Code.

f Avian Wildlife Protection – The solar evaporator shall be operated to ensure that avian wildlife is adequately protected as set forth in §22910 (a) and (v). The following Best Management practices are required:
(1) Solar evaporators (excluding water catchment basins) shall be kept free of all vegetation.
(2) Grit-sized gravel (<5 mm in diameter) shall not be used as a surface substrate within the solar evaporator.
(3)Netting or other physical barriers for excluding avian wildlife from water catchment basins shall not be allowed to sag into any standing water within the catchment basin.
(4) The emergence and dispersal of aquatic and semi-aquatic macro invertebrates or aquatic plants outside the boundary of the water catchment basin shall be prevented.
(5) The emergence of the pupae of aquatic and semi-aquatic macro invertebrates from the water catchment basins onto the netting, for use as a pupation substrate, shall be prevented.

g Inspection – The RWQCB issuing a Notice of Authority to Operate a solar evaporator shall conduct authorized inspections in accord with §25209.15 of Article 9.7 of the Health and Safety Code to ensure continued compliance with the requirements of this article. The RWQCB shall request an avian wildlife biologist to assist the RWQCB in its inspection of each authorized solar evaporator at least once annually during the month of May. If an avian wildlife biologist is not available, the RWQCB shall nevertheless conduct the inspection. During the inspection, observations shall be made for compliance with §22910 (a) and (v), and the following conditions that indicate a reasonable threat to avian wildlife:
(1) Presence of vegetation within the boundaries of the solar evaporator;
(2) Standing water or other mediums within the solar evaporator that support the growth and dispersal of aquatic or semi-aquatic macro invertebrates or aquatic plants;

(3) Abundant sustained avian pressure within the solar evaporator that could result in nesting activity;
(4) An apparent avian die-off or disabling event within the solar evaporator;
(5) Presence of active avian nests with eggs within the boundaries of the solar evaporator.

If active avian nests with eggs are found within the boundaries of the solar evaporator, the RWQCB shall report the occurrence to the USFWS and DFG within 24 hours, and seek guidance with respect to applicable wildlife laws and implementing regulations. Upon observation of active avian nests with eggs within the boundaries of the solar evaporator, all discharge of agricultural drainage water to the solar evaporator shall cease until

(a) the nests are no longer active, or (b) written notification is received by the owner or operator, from the RWQCB, waiving the prohibition of discharge in compliance with all applicable state and federal wildlife laws and implementing regulations (i.e., as per applicable exemptions and allowable take provisions of such laws and implementing regulations.)

See Appendix pages A-79 to A-88 for complete regulations.

Compliance with the regulations may be achieved by managing water volumes, allowing drying periods, and equipment used to control and pump the water, as well as recording the required monitoring data. The reporting requirements provided in the agreement with the RWQCB will define the equipment required to provide the necessary data.

Monitoring of the IFDM system consists of two parts, monitoring required by law and monitoring for management purposes. Monitoring required by law to provide data to the regional board and the state board is outlined in the permit for the IFDM system. The amount of monitoring for management purposes is up to the discretion of the farmer.

Drainage water volumes must be recorded and quality reported. This data may be useful to adjust irrigation practices. Soil monitoring is not required, but is recommended because it enables the tracking of the progress of the IFDM system (evaluate whether soil conditions are improving or declining) and provides information for fertilizer and nutrient applications. Salinity monitoring by EM-38 surveys are not required, but may be helpful to evaluate salinity conditions in soil over time.

The most important management task will be to ensure the reports are made to the regional and state boards as and when required.

F. Selenium Management

This will also be a learning process for operators of IFDM systems since selenium will be present in the drainage water, the soil, the groundwater, the plants being irrigated with saline water, and finally in the effluent and salt in the evaporator. The opportunities for management will be in the areas of salt management in the soil, leaching, and in the crop selection. Selenate is mobile in water and will move freely with the drainage water. When drainage water is used for irrigation the selenium will be transported to new areas and may accumulate in the soil profile.

This accumulation can be regulated by leaching and crop selection. Several crop species have been identified as accumulators and will extract selenium from the soil. These plants can be used as food supplements in animal production. It also should be noted that selenium will volatilize from the plants and soil.